

Claims

[c1] What is claimed is:

1.A method for forming a damascene interconnect structure with a bi-layer capping film, comprising the following steps:

providing a semiconductor wafer;

depositing a dielectric layer over the semiconductor wafer, the dielectric layer having a main surface and a damascened recess on the main surface;

depositing a copper layer in the damascened recess and to fill the damascened recess;

performing a chemical mechanical polishing process to polish the copper layer such that the copper layer has an exposed upper surface substantially co-planar with the main surface of the dielectric layer; and

capping the exposed upper surface with a bi-layer capping film consisting of a lower HDPCVD silicon nitride layer and an upper doped silicon carbide layer.

[c2] 2.The method according to claim 1 wherein after polishing the copper layer to form the upper surface and before capping the exposed upper surface with the bi-layer capping film, the upper surface is pre-treated by hydro-

gen or ammonia plasma for reducing residual copper oxides on the upper surface.

- [c3] 3.The method according to claim 2 wherein the hydrogen or ammonia plasma pre-treatment is carried out at a temperature of below 300°C for a time period of about 10 seconds to 60 seconds.
- [c4] 4.The method according to claim 1 wherein the lower HDPCVD silicon nitride layer is formed by high density plasma chemical vapor deposition (HDPCVD) at a temperature of below 350°C .
- [c5] 5.The method according to claim 1 wherein the upper doped silicon carbide layer is composed of oxygen doped silicon carbide (SiCOH) or nitrogen doped silicon carbide (SiCNH).
- [c6] 6.The method according to claim 5 wherein the upper doped silicon carbide layer is produced by a chemical vapor deposition (CVD) process, in which 3-methyl silane or 4-methyl silane is used as a precursor.